arXiv:physics/9911036 16 Nov 1999

9.84 *vs.* 9.84: The Battle of Bruny and Bailey

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Abstract
At the recent 1999 World Athletics Championships in Sevilla, Spain, Canada's Bruny Surin matched Donovan Bailey's National and former World Record 100 m mark of 9.84 s. The unofficial times for each, as read from the photo-finish, were 9.833 s and 9.835 s respectively. Who, then, is the fastest Canadian of all time? A possible solution is offered, accounting for drag effects resulting from ambient tail-winds and altitude.

From the moment Bruny Surin's silver-clad Seville performance popped up on the screen, it was only a matter of time before the question was raised.

This story, of course, has its roots in the July 27, 1996 performance of one Donovan Bailey, Canada's prime hopeful at the centennial Olympic Games in Atlanta. Coming from behind, Donovan shifted to a gear which that day only he possessed, surging ahead to the tape in a World Record mark of 9.84s. Fast forward to August 22, 1999: Montreal's Bruny Surin battles for global century supremacy with the formidable Maurice Greene, who a shy 2 months earlier had eclipsed Bailey's world mark in an ominously reminiscent 9.79s. Although falling mildly short of his rival's 9.80s gold medal romp, Surin's time was far from disappointing, yet in a way uniquely Canadian: 9.84s.

The score so far: 9.84s Bailey, 9.84s Surin– but is a 9.84s always a 9.84s? Without delving too deeply into the philosophical, one needs to address the standards of electronic timing. For those not familiar with the equipment, the top-of-the-line photo-finish cameras actually sample at 0.001s, implying that the athletes' performances are initially recorded to three decimal places. For various reasons, the precision is only kept to two places, but the rounding process isn't quite scientific. Unless the third decimal place is '0', the times are rounded *up* to the next highest hundredth. So, two performances can be up to 0.009s apart, and *still* be regarded as "equal"!

Herein lies our current dilemma. In a recent issue of *Athletics* [1], it was pointed out that Bailey's 9.84 s was initially a 9.835 s, while Surin's 9.84 s was really 9.833 s. How does reaction time fit in? Donovan slept in the blocks for 0.174 s (a potential nail-in-the-coffin for an Olympic final!), while Bruny blasted ahead of his field in 0.127 s. So, after a little math, Surin clocks in with 9.706 s, but Bailey now leads at 9.661 s.

Is Donovan's performance truly of Olympic proportions, as compared to Bruny's?? In case you didn't see this coming (by now you should all know better), we can't disregard two vital pieces of data: wind speed and altitude! The measurements in question were +0.7 m/s in Atlanta (approximately 315 m above sea level), and +0.2 m/s in Seville (about 12 m above sea level). Since a tail-wind boosts a sprint time, Bailey's +0.7 m/s tail gave him more of an advantage than Surin's +0.2 m/s. However, a higher altitude sprint is easier than one closer to sea level– hence, a Seville race will be slower than one in Atlanta! What to do?? Is this debate destined for the files of *Unsolved Mysteries*?

Through the miracle of numerical modeling, it's possible to estimate the benefit associated with each statistic. Drag is calculated as

$$drag = \frac{1}{2}\rho\, C_d\, A\, (v - w)^2\ , \tag{1}$$

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Altitude (m)	w: +0.0 m/s	+1.0 m/s	+2.0 m/s
0	+0.000 s	+0.064 s	+0.121 s
1000	+0.043	+0.099	+0.149
2000	+0.079	+0.130	+0.174
2234	+0.087	+0.137	+0.180

where A is the cross-sectional area of the sprinter, C_d is the drag coefficient, ρ the density of the air, v the sprinter's speed, and w the wind speed. Note the dependence on ρ and w: the higher the altitude, the thinner the air, the lower the value of ρ. Likewise, the stronger the tail wind, the smaller $(v-w)^2$ gets. Hence, both imply a lower overall drag on the sprinter. Since the effect of wind will vary with altitude, it's reasonable to convert all performances to their sea level equivalent (or 0 metres altitude). The following chart gives a quick indication of the degree to which a 9.72 s sea-level clocking (assuming reaction is subtracted) will be boosted by differing wind and altitude conditions. The last row represents the elevation of Mexico City, to give appreciation for the advantage experience in the 1968 Olympics (the density of air is roughly $76-78\%$ that at sea level, so clearly with the right tail wind, it's no wonder that the sprints and jumps experienced record-breaking performances).

Plugging the numbers into my model [2], I find the following quick figures: the altitude+wind combo for Bailey implies that his race would be equivalent to roughly a 9.719 s (+0.044 s from just wind; +0.058 s combined). Surin's race would correspond to a 9.720 s century (+0.013 s wind; +0.014 s combined).

There we have it: instead of 9.84 *vs.* 9.84, after correcting for reaction time and drag effects, we end up with 9.720 s *vs.* 9.719 s. Since exact values of C_d and A are unknown, their estimation introduces a degree of uncertainty to any calculation. So, it's certainly not unreasonable to expect that this could account for a 0.001s discrepancy, implying that Bailey's and Surin's times are effectively indistinguishable!

Thus, whose 9.84 s is faster? According to these preliminary results: they're *both* the fastest. But, with two 9.84 s clockings toping the national list, Canada certainly comes out ahead. Perhaps the 2000 season will shed some definitive light on the individual battle.

References

[1] Cecil Smith, "Inside Track", *Athletics: Canada's National Track and Field Running Magazine* (November 1999)

[2] J. R. Mureika, "A realistic mathematical sprint model accounting for wind and altitude effects" (*in preparation*)